PB-240 909

HOLLOWAY RESERVOIR, GENESEE AND LAPEER COUNTIES, MICHIGAN

Pacific Northwest Environmental
Research Laboratory

Prepared for:

National Environmental Research Center
Michigan Department of Natural Resources
Michigan National Guard

March 1975

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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivded according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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REPORT

ON

HOLLOWAY RESERVOIR

GENESEE AND LAPEER COUNTIES

MICHIGAN

EPA REGION V

WORKING PAPER No. 197

WITH THE COOPERATION OF THE

MICHIGAN DEPARTMENT OF NATURAL RESOURCES

AND THE

MICHIGAN NATIONAL GUARD

MARCH, 1975

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CONTENTS

	Page
Foreword	ii
List of Michigan Study Lakes	iv
Lake and Drainage Area Map	v
Sections	
I. Conclusions	1
II. Lake and Drainage Basin Characteristics	4
III. Lake Water Quality Summary	5
IV. Nutrient Loadings	10
V. Literature Reviewed	15
VI. Appendices	16

FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)] and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Michigan Department of Natural Resources for professional involvement and to the Michigan National Guard for conducting the tributary sampling phase of the Survey.

A. Gene Gazlay, former Director, and David H. Jenkins, Acting Director, Michigan Department of Natural Resources; and Carlos Fetterolf, Chief Environmental Scientist, and Dennis Tierney, Aquatic Biologist, Bureau of Water Management, Department of Natural Resources, provided invaluable lake documentation and counsel during the course of the Survey. John Vogt, Chief of the Bureau of Environmental Health, Michigan Department of Public Health, and his staff were most helpful in identifying point sources and soliciting municipal participation in the Survey.

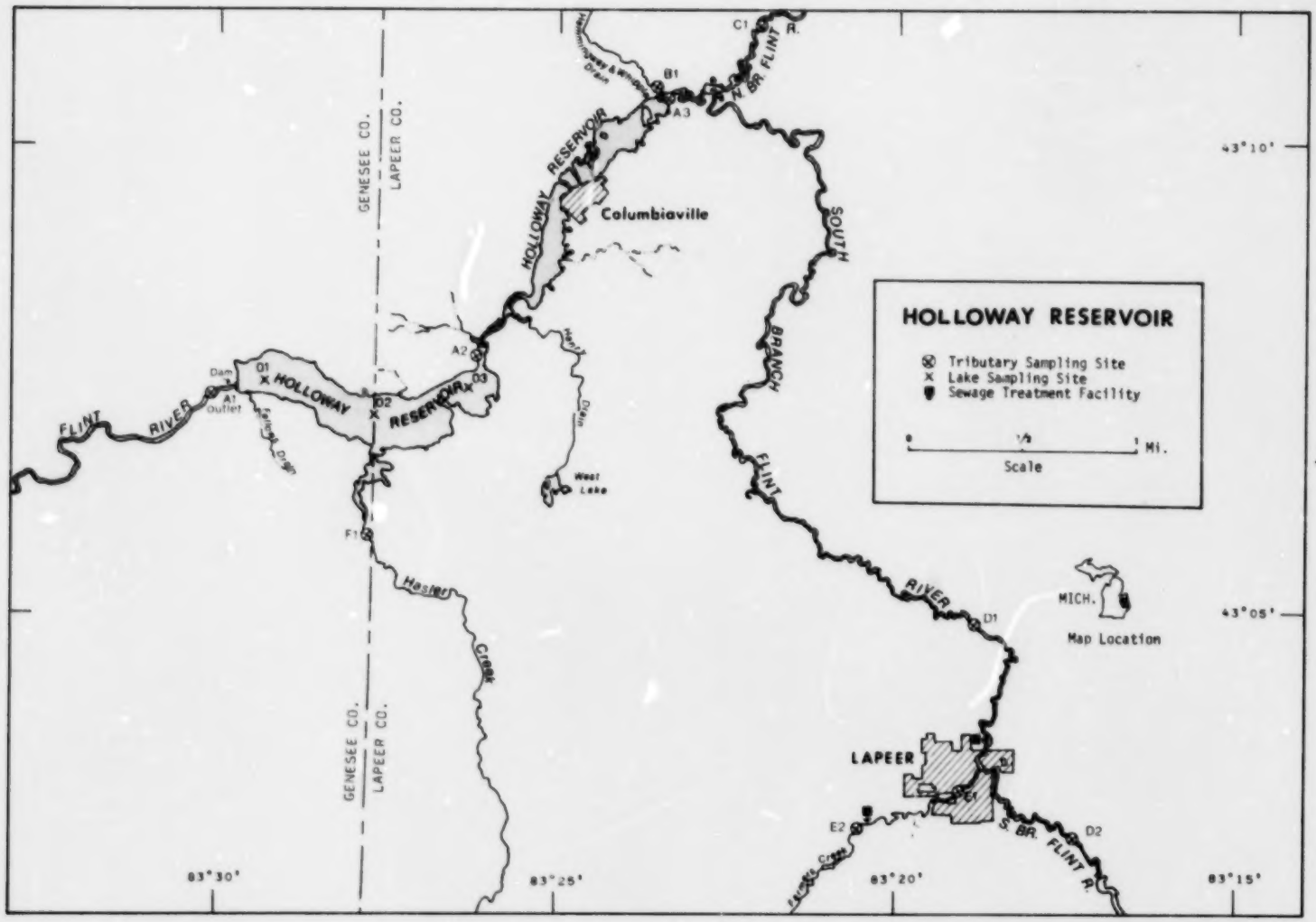
Major General Clarence A. Schnipke (Retired), then the Adjutant General of Michigan, and Project Officer Colonel Albert W. Lesky, who directed the volunteer efforts of the Michigan National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MICHIGAN

LAKE NAME	COUNTY
Allegan Res.	Allegan
Barton	Kalamazoo
Belleville	Wayne
Betsie	Benzie
Brighton	Livingston
Caro Res.	Tuscola
Charlevoix	Charlevoix
Chemung	Livingston
Constantine Res.	St. Joseph
Crystal	Montcalm
Deer	Marquette
Ford	Washtenaw
Fremont	Newago
Higgins	Roscommon
Holloway Res.	Genesee, Lapeer
Houghton	Roscommon
Jordon	Ionia, Barry
Kent	Oakland
Long	St. Joseph
Macatawa	Ottawa
Manistee	Manistee
Mona	Muskegon
Muskegon	Muskegon
Pentwater	Oceana
Pere Marquette	Mason
Portage	Houghton
Randall	Branch
Rogers Pond	Mecosta
Ross	Gladwin
St. Louis Res.	Gratiot
Sanford	Midland
Strawberry	Livingston
Thompson	Livingston
Thornapple	Barry
Union	Branch
White	Muskegon


HOLLOWAY RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
0
½
1 Mi.
Scale
Map Location
MICH.
Columbiaville
LAPEER
HOLLOWAY RESERVOIR
FLINT RIVER
SOUTH BRANCH FLINT RIVER
N BR. FLINT R.
S BR. FLINT R.
GENESEE CO.
LAPEER CO.
Hasler Creek
West Lake
Dam
Outlet
A1
A2
A3
B1
C1
C2
D1
D2
E1
E2
F1
01
02
03
43°10'
43°05'
83°30'
83°25'
83°20'
83°15'

HOLLOWAY RESERVOIR

STORET NO. 26A0

I. CONCLUSIONS

A. Trophic Condition:

Survey data show that Holloway Reservoir is eutrophic. Of the 35 Michigan lakes sampled in November when essentially all were well-mixed, 18 had less mean total phosphorus, 19 had less mean dissolved phosphorus, and 28 had less mean inorganic nitrogen; of the 41 lakes sampled, 12 had less mean chlorophyll a, and 14 had greater Secchi disc transparency*.

Some depression of oxygen with depth occurred at about the 10-foot depth at all sampling stations in September and also in June at stations 2 and 3, and Survey limnologists observed a blue-green algal bloom in September.

B. Rate-Limiting Nutrient:

The results of the algal assay show that the reservoir was phosphorus limited in September, 1972. The reservoir data indicate phosphorus limitation in November as well but nitrogen limitation in June.

C. Nutrient Controllability:

1. Point sources--During the sampling year, Holloway Reservoir received a total phosphorus load at a rate of about 58 lbs/acre/yr or about 6.5 $g/m^2/yr$. This rate is over four

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* See Appendix A.

times that proposed by Vollenweider (in press) as "dangerous"; i.e., a eutrophic rate (see page 14). However, Vollenweider's model probably does not apply to water bodies with short hydraulic retention times.

Now, the hydraulic retention time of Holloway Reservoir is not known but it is very likely that it is quite short. For example, the maximum depth sounded by Survey limnologists was 20 feet; and, if the mean depth is half that (i.e., 10 feet), the mean hydraulic retention time of the reservoir would be a rather short 19 days. The likelihood is that the hydraulic retention time is even less than that, and it is probable that Vollenweider's model does not apply.

It is calculated that the City of Lapeer and the Lapeer State Home contributed about 30% of the total phosphorus load during the sampling year. Provision of 85% phosphorus removal at these two sources would reduce the loading rate to about 4.8 $g/m^2/yr$. It is likely that this lower loading rate would result in persistent phosphorus limitation in the reservoir (see page 9) and would reduce the incidence and severity of nuisance algal blooms. Improvement in the trophic condition of the reservoir would be enhanced if the phosphorus export of the Flint River also can be reduced (see below).

2. Non-point sources--During the sampling year, the "non-point" phosphorus export of the Flint River (at station A-3) was over twice that of the other two streams studied (see page 13). That export rate and the export N/P ratio may be indicative of point sources in the Flint River drainage beyond the 25-mile limit of the Survey or cultural practices that result in nutrient inputs to the drainage.

Whatever the source of the export phosphorus, during the sampling year the Flint River drainage contributed a total phosphorus load to the reservoir at a rate of about 37 lbs/reservoir acre/yr or nearly 4.2 $g/m^2/yr$.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry†:

1. Surface area: 954 acres.
2. Mean depth: unknown.
3. Maximum depth: >15 feet.
4. Volume: unknown.

B. Tributary and Outlet:
(See Appendix B for flow data)

1. Tributaries -

Name	Drainage area*	Mean flow*
Flint River (A-3)	448.0 mi^2	212.5 cfs
Hasler Creek	28.3 mi^2	13.9 cfs
Hemmingway & Whipple Drain	8.0 mi^2	3.9 cfs
Minor tributaries & immediate drainage -	40.2 mi^2	20.3 cfs
Totals	524.5 mi^2	250.6 cfs

2. Outlet -

Flint River	526.0 mi^2**	250.6 cfs**

C. Precipitation***:

1. Year of sampling: 33.0 inches.
2. Mean annual: 30.1 inches.

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† Fetterolf, 1973.
* Drainage areas are accurate within ±5%; mean daily flows for 74% of the drainage areas are accurate within ±25% and the remaining sites up to ±40%; and mean monthly flows, normalized mean monthly flows, and mean annual flows are slightly more accurate than mean daily flows.
** Includes area of lake; flow adjusted to equal sum of inflows.
*** See Working Paper No. 1, "Survey Methods, 1972".

III. LAKE WATER QUALITY SUMMARY

Holloway Reservoir was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from three stations on the reservoir and from two or more depths at each station (see map, page v). During each visit, a single depth-integrated (near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the second visit, a single five-gallon depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 15 feet at station 1, 15 feet at station 2, and 10 feet at station 3.

The results obtained are presented in full in Appendix C, and the data for the fall sampling period, when the reservoir essentially was well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix C.

A. Physical and chemical characteristics:

Parameter	Minimum	Mean	Median	Maximum
		FALL VALUES (11/15/72)		
Temperature (Cent.)	3.4	4.2	4.2	4.7
Dissolved oxygen (mg/l)	10.6	10.9	11.0	11.4
Conductivity (μmhos)	650	658	650	690
pH (units)	7.9	7.9	7.9	8.0
Alkalinity (mg/l)	232	241	243	246
Total P (mg/l)	0.056	0.062	0.059	0.072
Dissolved P (mg/l)	0.037	0.043	0.040	0.053
NO_2 + NO_3 (mg/l)	1.020	1.215	1.215	1.460
Ammonia (mg/l)	0.140	0.246	0.235	0.420
		ALL VALUES		
Secchi disc (inches)	33	61	46	120

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
06/17/72	1. Cyclotella	579
	2. Schroederia	434
	3. Dinobryon	410
	4. Navicula	302
	5. Anabaena	241
	Other genera	712
	Total	2,678
09/19/72	1. Microcystis	2,952
	2. Anabaena	1,958
	3. Flagellates	331
	4. Melosira	271
	5. Dinobryon	181
	Other genera	753
	Total	6,446
11/15/72	1. Asterionella	1,392
	2. Phacus	443
	3. Melosira	325
	4. Rhaphidiopsis	154
	5. Dinobryon	145
	Other genera	669
	Total	3,128

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (µg/l)
06/17/72	01	3.8
	02	3.7
	03	9.1
09/19/72	01	15.7
	02	15.0
	03	18.0
11/15/72	01	14.6
	02	11.2
	03	5.0

C. Limiting Nutrient Study:

1. Filtered and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.015	0.490	2.4
0.010 P	0.025	0.490	8.1
0.020 P	0.035	0.490	11.7
0.050 P	0.065	0.490	12.4
0.050 P + 5.0 N	0.065	5.490	27.1
0.050 P + 10.0 N	0.065	10.490	28.2
10.0 N	0.015	10.490	2.5

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Holloway Reservoir was relatively high at the time the sample was collected (09/19/72). Also, the increased yields

with increased levels of orthophosphorus indicates the reservoir was phosphorus limited at that time. Note that the addition of only nitrogen produced a yield not significantly greater than the control yield.

The lake data indicate phosphorus limitation in November as well (N/P ratio = 34/1) but nitrogen limitation in June (N/P = 6/1).

IV. NUTRIENT LOADINGS
(See Appendix D for data)

For the determination of nutrient loadings, the Michigan National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of April and May when two samples were collected. Sampling was begun in October, 1972, and was completed in September, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Michigan District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loadings for "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated by using the nutrient loads, in lbs/mi^2/year, in Hasler Creek at station F-1 and multiplying by the ZZ area in mi^2.

The operators of the City of Lapeer and the Lapeer State Home wastewater treatment plants provided monthly effluent samples and corresponding flow data. In this report, the nutrient loads given for the Flint River are those measured at station A-3 minus the point-source loads.

The Village of Columbiaville was assumed to be served by septic tanks, and loads from there were estimated as septic tank loads*.

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* See Working Paper No. 1.

A. Waste Sources:

1. Known municipal† -

Name	Pop. Served	Treatment	Mean Flow (mgd)	Receiving Water
Lapeer	6,270*	trickling filter	0.800	S. Br., Flint River
Lapeer State Home	2,180**	trickling filter	0.321	Farmers Creek
Columbiaville	975*	septic tanks (?)	?	Holloway Reservoir

2. Known industrial - None

† Lehner, 1972.
* 1970 Census.
** Estimated on basis of measured nitrogen load/7.5 lbs per capita per year.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load) -		
Flint River (A-3)	35,550	64.1
Hasler Creek	1,070	1.9
Hemmingway & Whipple Drain	250	0.5
b. Minor tributaries & immediate drainage (non-point load) -	1,520	2.7
c. Known municipal STP's -		
Lapeer	12,510	22.6
Lapeer State Home	4,100	7.4
Columbiaville	240	0.4
d. Septic tanks* -	50	0.1
e. Known industrial - None	-	-
f. Direct precipitation** -	150	0.3
Total	55,440	100.0

2. Outputs -

Lake outlet - Flint River 35,570

3. Net annual P accumulation - 19,870 pounds

* Estimate based on 75 shoreline dwellings; see Working Paper No. 1.
** See Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	lbs N/yr	% of total
a. Tributaries (non-point load) -		
Flint River (A-3)	853,800	80.5
Hasler Creek	50,550	4.8
Hemmingway & Whipple Drain	12,580	1.2
b. Minor tributaries & immediate drainage (non-point load) -	71,810	6.8
c. Known municipal STP's -		
Lapeer	35,240	3.3
Lapeer State Home	16,330	1.5
Columbiaville	9,160	0.9
d. Septic tanks* -	1,760	0.2
e. Known industrial - None	-	-
f. Direct precipitation** -	9,190	0.8
Total	1,060,420	100.0

2. Outputs -

Lake outlet - Flint River 1,072,380

3. Net annual N loss - 11,960 pounds

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	lbs P/mi^2/yr	lbs N/mi^2/yr	N/P Ratio
Flint River (A-3)	79	1,906	24/1
Hasler Creek	38	1,786	47/1
Hemmingway & Whipple Drain	31	1,572	51/1

* Estimate based on 75 shoreline dwellings; see Working Paper No. 1.
** See Working Paper No. 1.

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (in press). Essentially, his "dangerous" rate is the rate at which the receiving water would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with very short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
Units	Total	Accumulated	Total	Accumulated
lbs/acre/yr	58.1	20.8	1,111.6	loss*
grams/m^2/yr	6.51	2.33	124.6	-

Vollenweider loading rates for phosphorus ($g/m^2/yr$) based on surface area and mean outflow of Holloway Reservoir:

"Dangerous" (eutrophic rate)	1.44
"Permissible" (oligotrophic rate)	0.72

* There was an apparent loss of nitrogen during the sampling year. This may have been due to nitrogen fixation in the reservoir, resolubilzation of previously sedimented nitrogen, or recharge with nitrogen-rich ground water. Whatever the cause, a similar loss of nitrogen has been observed at Shagawa Lake, Minnesota, which has been studied intensively by EPA's National Eutrophication and Lake Restoration Branch.

V. LITERATURE REVIEWED

Lehner, Richard A., 1972. Treatment plant questionnaires (Lapeer and Lapeer State Home facilities). MI Dept. of Publ. Health, Lansing.

Vollenweider, Richard A. (in press). Input-output models. Schweiz. Z. Hydrol.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	FALL VALUES MEAN TOTAL P	FALL VALUES MEAN DISS P	FALL VALUES MEAN INORG N	ALL VALUES 500-MEAN SEC	ALL VALUES MEAN CHLURA	ALL VALUES 15-MIN UO
2640	HOLLOWAY RESERVOIR	0.062	0.043	1.461	439.375	10.678	9.200
2641	CARO RESERVOIR	0.117	0.022	3.835	473.000	11.967	9.500
2642	BOARDMAN HYDRO POND	0.006	0.005	0.358	363.500	1.267	6.600
2643	ALLEGAN LAKE	0.123	0.057	1.168	470.222	20.311	12.600
2646	HARTON LAKE	0.121	0.006	1.489	456.167	27.800	14.850
2649	BELLEVILLE LAKE	0.110	0.048	1.420	465.250	28.262	8.200
2650	BETSIE LAKE	0.025	0.006	0.273	461.667	4.567	7.400
2653	BRIGHTON LAKE	0.109	0.073	1.015	456.000	44.233	7.500
2657	LAKE CHARLEVOIX	0.007	0.006	0.230	351.250	3.008	9.240
2658	LAKE CHEMUNG	0.044	0.014	0.132	404.333	13.483	14.800
2661	CONSTANTINE RESERVOIR	0.027	0.008	0.910	456.167	39.317	7.500
2669	FORD LAKE	0.185	0.054	1.536	456.167	14.733	14.000
2671	FREMONT LAKE	0.372	0.342	1.406	441.667	28.500	14.800
2680	JORDAN LAKE	0.160	0.144	1.998	427.667	20.517	14.900
2683	KENT LAKE	0.040	0.015	0.417	455.000	33.944	13.000
2688	LAKE MACATAWA	0.197	0.120	2.358	477.600	25.600	12.200
2689	MANISTEE LAKE	0.018	0.010	0.304	451.333	6.317	11.340
2699	MUSKEGON LAKE	0.067	0.043	0.469	430.444	9.511	14.800
2705	PENTWATER LAKE	0.027	0.017	0.496	430.667	10.083	14.800
2711	RANDALL LAKE	0.246	0.183	0.810	457.333	27.217	8.020
2712	ROGERS POND	0.026	0.015	0.183	435.500	8.133	9.600
2713	RUSS RESERVOIR	0.034	0.021	0.460	465.333	10.383	8.200
2714	SANFORD LAKE	0.016	0.008	0.307	458.750	13.791	8.300
2723	THORNAPPLE LAKE	0.042	0.032	1.737	442.833	14.450	10.800
2725	UNION LAKE	0.083	0.064	1.252	455.500	15.667	8.200
2728	WHITE LAKE	0.027	0.019	0.367	417.778	9.211	13.400
2731	MUNA LAKE	0.307	0.241	0.963	451.667	27.783	14.100
2732	LONG LAKE	0.163	0.148	0.749	418.400	10.067	13.600

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	FALL VALUES MEAN TOTAL P	FALL VALUES MEAN DISS P	FALL VALUES MEAN INORG N	ALL VALUES 500- MEAN SEC	ALL VALUES MEAN CHLORA	ALL VALUES 15- MIN DO
2693	ST LOUIS RESERVOIR	0.134	0.093	1.227	462.667	5.583	8.420
2694	CRYSTAL LAKE	0.009	0.006	0.164	380.000	2.986	13.000
2695	HIGGINS LAKE	0.007	0.005	0.058	268.500	1.043	9.400
2696	HOUGHTON LAKE	0.018	0.008	0.136	420.833	9.217	8.200
2697	THOMPSON LAKE	0.043	0.029	0.436	407.889	11.967	14.800
2698	PERE MARQUETTE LAKE	0.032	0.024	0.346	448.667	11.833	8.600
2699	STRAWBERRY LAKE	0.069	0.050	0.567	419.800	11.117	13.600

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	ALL VALUES: MEAN TOTAL P	ALL VALUES: MEAN DISS P	ALL VALUES: MEAN INORG N	ALL VALUES: SDD-MEAN SEC	ALL VALUES: MEAN CHLORA	ALL VALUES: 1S-MIN DO	INDEX NO
26A0	HOLLOWAY RESERVOIR	46 (16)	43 (15)	17 (6)	57 (20)	60 (21)	63 (22)	286
26A1	CARO RESERVOIR	29 (10)	54 (19)	0 (0)	3 (1)	49 (17)	54 (19)	189
26A2	BOARDMAN HYDRO POND	97 (34)	97 (34)	69 (24)	91 (32)	94 (33)	97 (34)	545
2603	ALLEGAN LAKE	20 (7)	31 (11)	31 (11)	6 (2)	29 (10)	40 (14)	157
2606	BANTON LAKE	23 (8)	20 (7)	14 (5)	29 (9)	14 (5)	3 (1)	103
2609	BELLEVILLE LAKE	26 (9)	37 (13)	20 (7)	11 (4)	11 (4)	79 (26)	184
2610	BETSIE LAKE	77 (27)	77 (27)	80 (28)	17 (6)	86 (30)	94 (33)	431
2613	BRIGHTON LAKE	31 (11)	23 (8)	34 (12)	34 (12)	0 (0)	90 (31)	212
2617	LAKE CHARLEVOIX	91 (32)	91 (32)	83 (29)	94 (33)	89 (31)	60 (21)	508
2618	LAKE CHEMUNG	49 (17)	71 (25)	94 (33)	86 (30)	46 (16)	11 (2)	357
2621	CONSTANTINE RESERVOIR	71 (25)	83 (29)	40 (14)	29 (9)	3 (1)	90 (31)	316
2629	FORD LAKE	34 (12)	29 (10)	11 (4)	29 (9)	37 (13)	23 (8)	163
2631	FREMONT LAKE	0 (0)	0 (0)	23 (8)	54 (19)	9 (3)	11 (2)	97
2640	JORDAN LAKE	11 (4)	11 (4)	6 (2)	69 (24)	26 (9)	0 (0)	123
2643	KENT LAKE	57 (20)	69 (24)	63 (22)	40 (14)	6 (2)	36 (12)	271
2648	LAKE MACATAWA	9 (3)	14 (5)	3 (1)	0 (0)	23 (8)	43 (15)	92
2649	MANISTEE LAKE	80 (28)	74 (26)	77 (27)	46 (16)	80 (28)	46 (16)	403
2659	MUSKEGON LAKE	37 (13)	40 (14)	54 (19)	60 (21)	69 (24)	11 (2)	271
2665	PENTWATER LAKE	69 (24)	63 (22)	51 (18)	66 (23)	31 (11)	11 (2)	291
2671	RANDALL LAKE	6 (2)	6 (2)	43 (15)	23 (8)	20 (7)	86 (30)	184
2672	ROGERS POND	74 (26)	66 (23)	86 (30)	63 (22)	77 (27)	51 (18)	417
2673	ROSS RESERVOIR	60 (21)	57 (20)	57 (20)	9 (3)	63 (22)	79 (26)	325
2674	SANFORD LAKE	86 (30)	80 (28)	74 (26)	20 (7)	43 (15)	71 (25)	374
2683	THORNAPPLE LAKE	54 (19)	46 (16)	9 (3)	51 (18)	40 (14)	49 (17)	249
2685	UNION LAKE	40 (14)	26 (9)	26 (9)	37 (13)	34 (12)	79 (26)	242
2688	WHITE LAKE	66 (23)	60 (21)	66 (23)	80 (28)	74 (26)	31 (11)	377
2691	MONA LAKE	3 (1)	3 (1)	37 (13)	43 (15)	17 (6)	20 (7)	123
2692	LONG LAKE	14 (5)	9 (3)	46 (16)	77 (27)	66 (23)	27 (9)	239

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	FALL VALUES: MEAN TOTAL P	FALL VALUES: MEAN DISS P	FALL VALUES: MEAN INORG N	ALL VALUES: 500- MEAN SEC	ALL VALUES: MEAN CHLORA	ALL VALUES: 15- MIN DO	INDEX NO
2693	ST LOUIS RESERVOIR	17 (6)	17 (6)	29 (10)	14 (5)	83 (29)	69 (24)	229
2694	CRYSTAL LAKE	89 (31)	89 (31)	89 (31)	89 (31)	91 (32)	36 (12)	483
2695	HIGGINS LAKE	94 (33)	94 (33)	97 (34)	97 (34)	97 (34)	57 (20)	536
2696	HOUGHTON LAKE	83 (29)	86 (30)	91 (32)	71 (25)	71 (25)	79 (26)	481
2697	THOMPSON LAKE	51 (18)	49 (17)	60 (21)	83 (29)	51 (18)	11 (2)	305
2698	PERE MARQUETTE LAKE	63 (22)	51 (18)	71 (25)	49 (17)	54 (19)	66 (23)	354
2699	STRAWBERRY LAKE	43 (15)	34 (12)	49 (17)	74 (26)	57 (20)	27 (9)	284

APPENDIX B

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR MICHIGAN 2/24/75

LAKE CODE 26A0 HOLLOWAY RESERVOIR

TOTAL DRAINAGE AREA OF LAKE(SQ MI) 526.00

TRIBUTARY	SUB-DRAINAGE AREA(SQ MI)	NORMALIZED FLOWS(CFS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
26A0A1	526.00	164.00	266.00	699.00	529.00	404.00	176.00	118.00	136.00	132.00	124.00	114.00	152.00	251.19
26A0A3	448.00	189.00	282.00	542.00	489.00	323.00	173.00	67.00	58.00	68.00	82.00	124.00	160.00	212.51
26A0B1	8.03	3.50	5.20	10.00	9.10	6.00	3.20	1.20	1.10	1.20	1.50	2.30	2.90	3.92
26A0F1	28.30	12.40	18.60	35.50	32.00	21.20	11.40	4.40	3.80	4.40	5.40	8.00	10.40	13.92
26A0ZZ	41.70	18.10	27.10	51.80	46.80	30.90	16.60	6.30	5.50	6.30	7.80	11.80	15.20	20.29

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 526.00
SUM OF SUB-DRAINAGE AREAS = 526.03
TOTAL FLOW IN = 3015.90
TOTAL FLOW OUT = 3014.00

MEAN MONTHLY FLOWS AND DAILY FLOWS(CFS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
26A0A1	10	72	174.00	28	450.00				
	11	72	290.00	26	242.00				
	12	72	441.00	26	440.00				
	1	73	1030.00	20	696.00				
	2	73	366.00	17	220.00				
	3	73	1260.00	24	1660.00				
	4	73	904.00	21	192.00	28	540.00		
	5	73	453.00	19	542.00	29	368.00		
	6	73	362.00	23	138.00				
	7	73	193.00	22	103.00				
	8	73	145.00	25	144.00				
	9	73	129.00	27	175.00				
26A0A3	10	72	159.00	28	493.00				
	11	72	290.00	26	277.00				
	12	72	410.00	26	439.00				
	1	73	1050.00	20	616.00				
	2	73	338.00	17	300.00				
	3	73	1120.00	24	993.00				
	4	73	644.00	21	300.00	28	385.00		
	5	73	397.00	19	308.00	29	277.00		
	6	73	280.00	23	116.00				
	7	73	152.00	22	67.00				
	8	73	69.00	25	37.00				
	9	73	31.00	27	45.00				

TRIBUTARY FLOW INFORMATION FOR MICHIGAN 2/24/75

LAKE CODE 26A0 HOLLOWAY RESERVOIR

MEAN MONTHLY FLOWS AND DAILY FLOWS(CFS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
26A0B1	10	72	2.90	28	9.00				
	11	72	5.30	26	5.10				
	12	72	7.50	26	8.00				
	1	73	19.00	20	11.00				
	2	73	6.20	17	5.50				
	3	73	21.00	24	18.00				
	4	73	12.00	21	5.50	28	7.00		
	5	73	7.30	19	5.60	29	5.10		
	6	73	5.10	23	2.10				
	7	73	2.80	22	1.20				
	8	73	1.30	25	0.70				
	9	73	0.60	27	0.80				
26A0F1	10	72	10.00	28	32.00				
	11	72	19.00	26	18.00				
	12	72	27.00	26	28.00				
	1	73	68.00	20	40.00				
	2	73	22.00	17	20.00				
	3	73	73.00	24	64.00				
	4	73	42.00	21	20.00	28	25.00		
	5	73	26.00	19	20.00	29	18.00		
	6	73	18.00	23	7.50				
	7	73	9.90	22	4.40				
	8	73	4.50	25	2.40				
	9	73	2.00	27	3.00				
26A0ZZ	10	72	15.00						
	11	72	27.00						
	12	72	39.00						
	1	73	100.00						
	2	73	32.00						
	3	73	107.00						
	4	73	61.00						
	5	73	38.00						
	6	73	26.00						
	7	73	14.00						
	8	73	6.50						
	9	73	3.00						

APPENDIX C

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 75/02/04

26A001
43 07 17.0 083 29 21.0
HOLLOWAY RESERVOIR
26027 MICHIGAN

11EPALES 2111202
3 0014 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/17	10 30	0000	19.7	8.1	114	570	8.25	195	0.110	0.120	0.038	0.031
	10 30	0010	19.6	8.4		560	8.28	196	0.130	0.120	0.038	0.032
72/09/19	15 15	0000			54	480	8.25	181	0.100	0.650	0.062	0.043
	15 15	0004	21.1	7.4		480	8.23	183	0.090	0.640	0.076	0.046
	15 15	0015	20.7	5.8		470	8.05	178	0.100	0.700	0.068	0.047
72/11/15	09 40	0000			48	650	7.90	246	1.080	0.280	0.057	0.042
	09 40	0004	4.7	10.6		650	7.90	232	1.020	0.290	0.059	0.037
	09 40	0011	4.7	10.7		650	7.90	234	1.040	0.420	0.054	0.039

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/17	10 30	0000	3.8J
72/09/19	15 15	0000	15.7J
72/11/15	09 40	0000	14.6J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 75/02/04

26A002
43 06 52.0 083 27 32.0
HOLLOWAY RESERVOIR
26 MICHIGAN

11EPALES
3

2111202
0020 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/17	10 50	0000	20.3	9.0	120	575	8.40	199	0.110	0.080	0.033	0.027
	10 50	0015	20.1	8.5		575	8.33	201	0.110	0.090	0.035	0.027
72/09/19	15 35	0000			36	476	8.30	186	0.090	0.430	0.046	0.026
	15 35	0004	21.2	7.7		480	8.30	183	0.090	0.490	0.057	0.031
	15 35	0011	20.7	7.0		480	8.23	184	0.100	0.470	0.051	0.027
72/11/15	09 15	0000			44	650	8.00	246	1.260	0.240	0.059	0.040
	09 15	0004	4.2	11.0		650	8.00	244	1.240	0.230	0.056	0.040
	09 15	0008	4.2	11.0		650	8.00	236	1.190	0.230	0.063	0.039

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/17	10 50	0000	3.7J
72/09/19	15 35	0000	15.0J
72/11/15	09 15	0000	11.2J

J VALUE KNOWN TO BE IN ERROR

26

STORET RETRIEVAL DATE 75/02/04

264003
43 07 16.0 083 26 12.0
MULLOWAY RESERVOIR
26 MICHIGAN

11EPALES
3

2111202
0010 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/17	11 00	0000	20.6	10.2		595	8.48	245	0.030	0.050	0.040	0.030
	11 00	0010	20.2	8.4		590	8.42	245	0.040	0.040	0.040	0.030
72/09/19	15 52	0000			33	510	8.65	222	0.070	0.110	0.053	0.028
	15 52	0004	21.4	11.2		500	8.65	220	0.070	0.120	0.064	0.032
	15 52	0009	21.0	9.8		495	8.40	197	0.100	0.300	0.062	0.029
72/11/15	09 30	0000			36	690	7.90	242	1.430	0.140	0.072	0.053
	09 30	0004	3.4	11.4		670	7.90	246	1.460	0.140	0.072	0.053

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/17	11 00	0000	9.1J
72/09/19	15 52	0000	18.0J
72/11/15	09 30	0000	5.0J

J VALUE KNOWN TO BE IN ERROR

APPENDIX D

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 75/02/04

26A0A1 LS26A0A1
43 07 00.0 083 30 00.0
FLINT RIVER
26027 7.5 ELBA
U/HOLLOWAY RESERVOIR
OAK RD BRD BELO DAM SW OF COLUMBIAVILLE
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/28	16 30		0.130	2.000	0.260	0.011	0.063
72/11/26	12 55		1.100	1.890	0.044	0.048	0.065
72/12/26	11 20		1.440	2.600	0.198	0.026	0.060
73/01/20	12 55		1.940	1.500	0.130	0.028	0.060
73/02/17	14 05		1.260	1.100	0.140	0.033	0.055
73/03/24	12 50		1.100	1.100	0.067	0.017	0.050
73/04/21	12 00		0.550	1.380	0.048	0.006	0.055
73/04/28	14 05		0.240	1.300	0.014	0.009	0.070
73/05/19	12 40		0.077	1.800	0.040	0.009	0.065
73/05/29	18 15		0.069	1.320	0.054	0.015	0.065
73/06/23	14 00		0.088	1.510	0.252	0.033	0.085
73/07/22	19 05		0.070	1.700	0.450	0.052	0.100
73/08/25	13 30		0.023	1.360	0.090	0.022	0.075
73/09/27	18 20		0.016	1.150	0.115	0.029	0.108

STORET RETRIEVAL DATE 75/02/04

26AUA2 LS26AUA2
43 07 30.0 083 26 00.0
FLINT RIVER
26 7.5 COLUMBIAVILL
T/HULLOWAY RESERVOIR
AT MORRIS RD BRDG SW OF COLUMBIAVILLE
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/28	13 15		1.240	1.400	0.180	0.050	0.120
72/11/26	13 05		1.160	1.150	0.168	0.046	0.085
72/12/26	11 30		2.090	1.400	0.138	0.029	0.065
73/01/20	13 10		1.120		0.132	0.027	
73/02/17			1.060	1.100	0.168	0.039	0.075
73/03/24	13 05		1.040	0.460	0.024	0.017	0.040
73/04/21	12 10		0.520	1.900	0.100	0.028	0.105
73/04/28	14 15		0.231	2.520	0.080	0.017	0.070
73/05/19	12 50		0.280	1.340	0.014	0.011	0.065
73/05/24	18 30		0.022	1.200	0.031	0.014	0.055
73/06/23	14 10		0.025	2.310	0.066	0.025	0.110
73/07/22	19 30		0.038	1.760	0.058	0.023	0.095
73/08/25	13 35		0.025	1.760	0.126	0.023	0.130
73/09/27	18 36		0.810	1.320	0.480	0.019	0.135

STORET RETRIEVAL DATE 73/02/04

26AQAJ L526AQAJ
43 10 30.0 083 23 30.0
FLINT RIVER
26 7.5 COLUMBIAVILL
T/HOLLOWAY RESERVOIR
KLAM RD BRDG NE OF COLUMBIAVILLE
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/28	13 40		1.240	1.400	0.120	0.055	0.110
72/11/26	14 20		0.780	2.100	0.017	0.006	0.079
72/12/26	11 55		1.560	2.100	0.138	0.035	0.086
73/01/20	14 10		1.220	1.340	0.120	0.042	0.090
73/02/17			1.100	1.050	0.147	0.046	0.105
73/03/24	13 45		1.100	0.930	0.054	0.023	0.045
73/04/21	12 30		0.430	1.050	0.029	0.041	0.085
73/04/28	14 35		0.315	1.100	0.020	0.040	0.085
73/05/19	13 20		0.380	1.490	0.042	0.036	0.090
73/05/29	19 00		0.410	1.440	0.096	0.056	0.120
73/06/23	14 20		0.340	2.200	0.054	0.080	0.175
73/07/22	19 15		0.300	1.050	0.014	0.120	0.145
73/08/25	13 55		0.280	1.800	0.043	0.138	0.220
73/09/27	19 00		0.470	0.570	0.126	0.126	0.230

STORET RETRIEVAL DATE 75/02/04

26AU81 LS26AU81
43 10 30.0 083 23 30.0
HEMINGWAY AND WHIPPLE DRAIN
26 7.5 COLUMBIAVILL
T/HOLLOWAY DAM
PIERSONVILLE RD XING NNE OF COLUMBIAVILL
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/28	14 00		0.790		0.092	0.005K	0.030
72/11/26	14 15		0.720	0.860	0.015	0.005K	0.014
72/12/26	11 50		1.330	1.320	0.054	0.005K	0.020
73/01/20	14 05		0.900	2.200	0.110	0.006	0.030
73/02/17			0.500	0.730	0.067	0.007	0.010
73/03/24	13 40		0.740	0.750	0.025	0.009	0.020
73/04/21	12 25		0.138	1.200	0.036	0.005K	0.020
73/04/28	14 30		0.040	2.200	0.075	0.005K	0.020
73/05/19	13 15		0.086	0.950	0.025	0.005K	0.020
73/05/29	18 40		0.630	1.380	0.031	0.010	0.050
73/06/23	14 22		0.036	1.380	0.063	0.032	0.115
73/07/22	19 45		0.056	1.000	0.056	0.027	0.050
73/08/25	13 50		0.010K	1.260	0.040	0.011	0.035
73/09/27	18 45		0.120	0.330	0.078	0.007	0.015

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/04

26AUC1 LS26AUC1
43 11 30.0 083 22 00.0
N BR FLINT RIVER
26 7.5 BARNES LAKE
T/HOLLOWAY RESERVOIR
BARNES LK RD BRDG 3.5 NE OF COLUMBIAVILLE
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/28	14 15		2.125	1.700	0.091	0.024	0.079
72/11/26	14 30		2.040	1.260	0.018	0.011	0.039
72/12/26	12 25		3.670	2.200	0.147	0.023	0.060
73/01/20	14 25		2.000		0.147	0.038	0.095
73/03/24	16 00		1.640	1.070	0.020	0.011	0.035
73/04/21	12 40		0.630	1.980	0.046	0.011	0.050
73/04/28	14 45		0.480	1.470	0.023	0.016	0.070
73/05/19	13 30		0.540	1.400	0.027	0.014	0.070
73/05/29	19 05		0.580	1.400	0.080	0.030	0.105
73/06/23	14 30		0.460	1.200	0.020	0.021	0.080
73/07/22	20 00		0.250	0.960	0.013	0.031	0.080
73/08/25	14 00		0.180	0.750	0.014	0.029	0.100
73/09/27	18 50		0.231	1.260	0.090	0.012	0.060

STORET RETRIEVAL DATE 75/02/04

26A0D1 LS26A0D1
43 05 00.0 083 18 30.0
S BR FLINT RIVER
26 7.5 LAPEER
T/HOLLOWAY RESERVOIR
ST HWY 24 BRDG BELO LAPEER STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/28	11 30		0.377	1.250	0.189	0.080	0.147
72/11/26	10 15		0.520	2.000	0.160	0.098	0.176
72/12/26	13 30		0.805	1.600	0.130	0.044	0.100
73/01/20	14 45		0.660	1.150	0.105	0.050	0.120
73/02/17			0.570	0.830	0.154	0.044	0.095
73/03/24	16 45		0.520	0.970	0.072	0.033	0.085
73/04/21	13 00		0.210	1.680	0.115	0.069	0.110
73/04/28	15 00		0.180	1.680	0.115	0.066	0.130
73/05/19	13 50		0.160	1.300	0.115	0.098	0.200
73/05/29	15 35		0.440	1.900	0.150	0.110	0.220
73/06/23	14 45		0.300	1.680	0.273	0.140	0.290
73/07/22	18 30		0.540	1.700	0.360	0.310	0.420
73/08/25	14 15		0.410	1.260	0.160	0.270	0.360
73/09/27	19 15		0.580	1.200	0.350	0.490	0.615

STORET RETRIEVAL DATE 75/02/04

26A002 LS26A002
43 02 30.0 083 17 00.0
5 4M FLINT RIVER
26 7.5 LAPEER
T/HULLOWAY RESERVOIR
MEYERS RD BRDG ABOV LAPEER STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/26	10 41		0.312	1.150	0.063	0.014	0.045
72/11/26	11 00		0.420	0.880	0.016	0.013	0.025
72/12/26	10 15		0.730	2.650	0.084	0.008	0.023
73/01/20	12 05		0.330		0.036	0.009	0.020
73/02/17	13 00		0.370	0.610	0.058	0.013	0.045
73/03/24	11 55		0.360	0.740	0.056	0.011	0.020
73/04/21	11 00		0.170	1.650	0.058		0.040
73/04/28	13 15		0.160	0.840	0.046	0.010	0.030
73/05/19	11 55		0.134	1.050	0.130	0.013	0.030
73/05/29	15 10		0.470	1.050	0.036	0.019	0.045
73/06/23	13 10		0.132	2.520	0.088	0.040	0.075
73/07/22	18 00		0.198	0.500	0.046	0.054	0.090
73/08/25	12 45		0.069	0.650	0.026	0.058	0.105
73/09/27	17 45		0.094	1.320	0.105	0.028	0.045

STORET RETRIEVAL DATE 75/02/04

26A0E1 LS26A0E1
43 03 00.0 083 19 00.0
FARMERS CREEK
26 7.5 LAPEER
T/HOLLOWAY RESERVOIR
ST HWY 21 BRDG BELO LAPEER ST HOME STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/28	10 30		0.117	1.200	0.150	0.063	0.154
72/11/26	11 50		0.420	2.600	0.170	0.096	0.388
72/12/26	10 30		0.740	2.400	0.180	0.063	0.147
73/01/20	12 15		1.100		0.120	0.071	
73/02/17	13 10		0.780	1.400	0.220	0.066	0.120
73/03/24	12 05		0.500	1.050	0.078	0.029	0.075
73/04/21	11 05		0.240	1.540	0.138	0.160	0.490
73/04/28	13 20		0.189	1.150	0.126	0.084	0.165
73/05/19	12 00		0.147	2.000	0.150	0.120	0.315
73/05/29	15 15		0.260	1.500	0.132	0.132	0.315
73/06/23	13 18		0.190	2.310	0.660	0.240	0.480
73/07/22	18 05		0.600	1.890	0.215	0.420	0.900
73/08/25	12 56		0.650	1.760	0.154	0.350	0.480
73/09/27	17 50		0.357	1.100	0.200	0.230	0.315

36

STORET RETRIEVAL DATE 75/02/04

26A0E2 LS26A0E2
43 02 30.0 083 20 30.0
FARMERS CREEK
26 7.5 LAPEER
T/HOLLOWAY RESERVOIR
DEMILL RD BRDG ABOV LAPEER ST HOME STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/28	11 10		0.055	0.850	0.074	0.010	0.062
72/11/26	12 05		0.325	6.150	0.290	0.010	0.036
72/12/26	10 40		0.630	1.500	0.050	0.008	0.023
73/01/20	12 20		1.060	1.600	0.058	0.010	0.020
73/02/17	13 20		0.760	0.950	0.048	0.013	0.025
73/03/24	12 15		0.440	0.880	0.035	0.016	0.025
73/04/21	11 15		0.138	1.320	0.069	0.011	0.035
73/04/28	13 30		0.058	1.200	0.023	0.012	0.030
73/05/19	12 05		0.023	1.260	0.138	0.014	0.032
73/05/29	15 25		0.050	1.600	0.052	0.036	0.060
73/06/23	13 25		0.030	1.380	0.045	0.054	0.100
73/07/22	18 15		0.200	1.020	0.050	0.063	0.095
73/08/25	13 00		0.060	1.780	0.050	0.029	0.065
73/09/27	18 00		0.056	0.930	0.160	0.027	0.075

STORET RETRIEVAL DATE 75/02/04

25A0F1 LS26A0F1
43 05 30.0 083 27 30.0
HASLER CREEK
26 7.5 ELBA
T/HOLLOWAY RESERVOIR
COLDWATER RD BRDG
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/28	16 00		0.960	1.400	0.088	0.007	0.037
72/11/26	12 45		0.560	2.310	0.063	0.007	0.022
73/01/20	12 45		0.760	1.760	0.110	0.013	0.035
73/02/17	13 46		0.610	1.300	0.150	0.011	0.040
73/03/24	12 35		0.470	1.050	0.020	0.007	0.020
73/04/21	11 45		0.220	1.980	0.126	0.014	0.045
73/04/28	13 55		0.150	1.260	0.028	0.009	0.040
73/05/19	12 30		0.090	1.320	0.027	0.011	0.035
73/05/29	18 20		0.176	1.700	0.066	0.020	0.060
73/06/23	13 45		0.189	1.700	0.198	0.014	0.045
73/07/22	19 00		0.132	1.050	0.078	0.019	0.050
73/08/25	13 30		0.066	0.880	0.054	0.011	0.035
73/09/27	18 15		0.060	1.600	0.115	0.009	0.035

38

STORET RETRIEVAL DATE 75/02/04

26A050 TF26A050 P007400
43 03 30.0 083 18 30.0
LAPEER
26027 7.5 LAPEER
T/HOLLOWAY RESERVOIR
FARMERS CREEK
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/01/23 08 00									
CP(T)-			1.680	7.350	0.635	2.100	3.000	0.827	0.954
73/01/23 16 00									
73/02/28			1.600	18.900	6.900	7.000	7.900		
73/04/03 08 00									
CP(T)-			2.930	4.400	0.290	1.045	1.650	1.000	1.100
73/04/03 16 00									
73/04/26 08 00									
CP(T)-			1.500	11.000	0.700	3.800	5.000	0.772	0.893
73/04/26 16 00									
73/05/26 08 00									
CP(T)-			1.200	14.000	1.600	4.600	5.820	0.786	0.901
73/05/26 16 00									
73/06/25 08 00									
CP(T)-			0.740	13.200	3.100	4.500	5.200	0.589	0.820
73/06/25 17 00									
73/07/31 08 00									
CP(T)-			2.300	8.500	0.200	2.900	4.200	0.947	0.617
73/07/31 16 00									
73/08/29 08 00									
CP(T)-				17.000	4.400	7.820	9.400	0.670	0.624
73/08/29 16 00									
73/09/27 08 00									
CP(T)-			1.050	15.400	3.100	7.200	8.200	0.661	0.637
73/09/27 16 00									
73/10/26 08 00									
CP(T)-			0.640	19.500	5.150	6.050	8.500	0.515	0.630
73/10/26 16 00									
73/11/26 08 00									
CP(T)-			2.730	15.500	7.140	1.890	2.800	1.120	0.910
73/11/26 16 00									
73/12/19 08 00									
CP(T)-			3.930	14.500	5.400	5.200	7.300	0.522	0.745
73/12/19 16 00									
74/02/13 08 00									
CP(T)-			0.800	17.000	4.300	4.400	5.800	0.672	0.775
74/02/13 16 00									

STORET RETRIEVAL DATE 73/02/04

26A051 TF26A051 P004500
43 03 00.0 083 20 00.0
LAPEER ST. HOME
26 7.5 LAPEER
T/HOLLOWAY RESERVOIR
FARMERS CREEK
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/01/29	07 00								
CP(T)- 73/01/29	15 30		7.400	13.600	2.000	3.800	4.300	0.280	0.280
73/02/27	07 00								
CP(T)- 73/02/27	15 30		7.600	14.000	5.100	4.100	5.400	0.260	0.260
73/03/28	08 00								
CP(T)- 73/03/28	14 00		8.600	7.100	1.050	2.900	3.200	0.390	0.450
73/04/27	07 00								
CP(T)- 73/04/27	15 00		13.400	7.400	2.600	4.300	5.200	0.270	0.265
73/05/31	07 00								
CP(T)- 73/05/31	14 00		9.750	6.000	1.220	3.750	4.300	0.330	0.340
73/06/25	07 00								
CP(T)- 73/06/25	15 00		8.500	8.300	3.600	3.400	4.800	0.330	0.330
73/07/31	07 00								
CP(T)- 73/07/31	14 00		9.500	2.200	1.360	3.400	3.750	0.330	0.340
73/08/24	07 00								
CP(T)- 73/08/29	14 00			4.700	1.100	3.500	3.800	0.360	0.350
73/09/27	07 00								
CP(T)- 73/09/27	14 30		9.100	3.700	0.140	4.200	4.400	0.320	0.320
73/10/25	07 00								
CP(T)- 73/10/25	14 00		11.400	10.500	0.680	5.200	5.600	0.280	0.300
73/11/29	07 00								
CP(T)- 73/11/29	14 00		10.200	9.900	0.104	3.250	4.200	0.320	0.300
73/12/27	07 00								
CP(T)- 73/12/27	14 00		7.700	4.900	0.330	2.300	2.500	0.650	0.320

-104-

STORET RETRIEVAL DATE 75/02/04

26A051 TF26A051 P004500
43 03 00.0 083 20 00.0
LAPEER ST. HOME
26 7.5 LAPEER
T/HOLLOWAY RESERVOIR
FARMERS CREEK
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
74/01/31	07 00								
CP(T)-			11.000	6.800	0.370	3.300	5.600	0.313	0.320
74/01/31	14 00								